PATENT SPECIFICATION

(11) 1454218

1454218

(21) Application No. 54946/74 (22) Filed 19 Dec. 1974

(31) Convention Application No. 428470 (32) Filed 26 Dec. 1973 in

(33) United States of America (US)

(44) Complete Specification published 3 Nov. 1976

(51) INT CL² D04H 13/00

(52) Index at acceptance

D1R 3A1 3B1 3C2B 3C2C 3C2F 3C2G 3C2X 3C2Y 3D2X 3D3C 3D3D 3D3E 3D3J

B5N 0502 0526 2702 2732

(19)

THE PATENT OFFICE LONDON

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(54) SURFACE DYEABLE NON-WOVEN FABRICS

(71) We, SUN VENTURES INC., a Corporation organised under the laws of the State of Pennsylvania U.S.A. of 240 Radnor-Chester Road, St. Davids, Pennsylvania 19087, U.S.A., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to oriented foam fibrillated webs and to non-woven fabrics.

In the past there has been considerable effort to find a way of forming fabric-like materials by means other than weaving or knitting. Weaving fabrics is an expensive operation, particularly when the woven material is made of fibre slivers. Needle punching of layers of fibrillated film is used for some purposes, but for many purposes such as carpet backing the layers are not sufficiently ulitized. Woven slit film eliminates the carding or garneting of fibres but still involves the expensive weaving. When such woven slit film is used as carpet backing it normally is made of polypropylene. The facing material used in the manufacture of carpeting is generally polyester, nylon or other dyeable material. When making shag carpets a portion of the backing often has a tendency to show through the facing. Since polypropylene is not dyed by the dyes normally used in dyeing carpeting and it is desired to have the backing dyed the same colour as the facing the propylene woven slit film carpet backing is generally needle punched with nylon or polyester filaments when it is to be used in the manufacture of shag carpeting. This results in a more expensive carpet backing and also causes a significant loss of strength.

Accordingly the present invention provides an oriented foam fibrillated web formed of a blend of from 30 to 80 percent by weight of polypropylene and from 20 to 70 percent by weight of a more hydrophilic dyeable resin which web weighs from 0.1 to 2 ounces per square yard.

The present invention relates to forming novel non-woven fabrics and particularly surface dyeable carpet backing from foam fibrillated webs. The main structural portion of the non-woven fabric is prepared from a polypropylene based resinous material. On one or both surfaces are applied one or more layers of a foam fibrillated web of a blend of polypropylene and a more hydrophilic resin. This serves to provide a dye receptive surface while still contributing to the overall strength of the final non-woven fabric. Generally the use of a blend in forming the surface webs results in a significant improvement in overall strength of the non-woven fabric product on a weight basis as compared with forming the surface webs of the more hydrophilic resin alone. This appears to be due to better bonding of the blends to the inner polypropylene resin based webs. The various webs are assembled into a plurality of layers by any suitable means such as simply unrolling some webs onto a carrier belt and cross-lapping some other layers to provide strength across the machine direction of the final non-woven fabric. The assembled layers are finally laminated together using a combination of heat and pressure. If simple heat and pressure does not provide the bond strength desired an adhesive may be used. A convenient adhesive system is the incorporation in the system of one or more films of a polyolefin having a softening point lower than that of the polypropylene based resin such as polyethylene such as by simply unrolling such film or films onto one or more of the polypropylene based resin webs during lay up of the non-woven fabric layers.

The invention is further illustrated by the accompanying drawing wherein:

Figure I is a schematic side view of the foam extrusion and fibrillation apparatus.

Figure II is a schematic side view of the laminating apparatus.

In Figure I synthetic resin pellets are fed to hopper 1 of feed meter 2, along with whatever blowing agent is required. The synthetic resin pellets are fed at a controlled rate from feed meter 2 to feed hopper 3 of extruder 4 as free falling pellets 5. Extruder 4 is equipped with a slit die 6, the slit of which is offset from the extruder feed port so as to build up sufficient back pressure t provide for a uniform feed rate across the width of the die. The extrudate is taken up and attenuated by a first pair of nip rolls 7,7'. As the extrudate leaves the die it is air quenched by means of an air quench manifold 8 which contains ports directed at the extrudate. A hood 9 is provided to remove the gaseous blowing agent which may contain noxious fumes from the atmosphere. First nip rolls 7,7' are operated at a rate from 2 to 10 times the rate at which the polypropylene is supplied to the lips of die 6 by extruder 4. This serves to break the foam bubbles as they approach the lips of die 6 within the die or immediately as they leave die 6, whereby a foam fibrillated web 10 of polypropylene is formed. The foam fibrillated web is fed over heated shoe 11 and drawn by second pair of nip rolls 12,12'. Generally second pair of nip rolls 12,12' are driven at a surface speed rate of from 2 to 8 times the surface speed rate of first pair of nip rolls 7,7' to orient and thereby strengthen foam fibrillated web 10. The thus oriented foam fibrillated web 10 is then taken up on take-up reel 13.

In Figure II a reel 14 of foam fibrillated polypropylene based resin web 15 is fed onto carrier belt 16. A layer of bonding film 17 is fed on top of web 15 from reel 18. An additional layer of foam fibrillated polypropylene resin based web 19 is fed from reel 20, supported overhead by means not shown, to lapper 21. Lapper 21 contains a pair of driven nip rolls mounted in a carriage. The nip rolls feed the foam fibrillated web onto bonding film 17 while being moved back and forth across bonding film 17 in the carriage. This results in the foam fibrillated web being laid down at a 45° angle to the machine direction in a double thickness. A second reel 22 feeds a foam fibrillated polypropylene based resin web 23 through lapper 24 onto lapped foam fibrillated web 21 to form two layers of foam fibrillated web 23 each disposed at 45° to the machine direction. An additional layer of bonding film 25 is laid on top of foam fibrillated web 23 from reel 26. A final layer of a foam fibrillated web formed from a blend of polypropylene and a hydrophilic resin 27 is fed from reel 28 on top of bonding film 25. The entire lay-up of foam fibrillated webs and bonding film is then removed from carrier belt 16 and fed through heated laminating rolls 29,29' to form non-woven fabric 30 which is taken up on take-up reel 31.

In preparing the foam fibrillated webs of the present invention several extrusion and drawing techniques may be used. The drawings show the preferred technique. However for instance the extruder may be fed by any of a large number of alternate means including manually from sacks of resin pellets. For small runs a ram-type extruder can be used but obviously it is desired to operate more or less continuously and for this a screw-type extruder is preferred. A slit die has been shown and has been found most convenient for forming relatively narrow width webs of from 6 inches to 3 feet. For wider webs of from 3 to 20 feet an annular die has obvious advantages. When using such an annular die the web is drawn over a mandrel to maintain or slightly increase its circumference, during orientation.

The extruder used may be equipped with a port to inject the blowing agent. If this is done, various blowing agents may be used such as the various Freons (Registered Trade Mark), methylene chloride, nitrogen or carbon dioxide. If the extruder is not equipped with a port to inject the blowing agent the blowing agent is fed into the extruder along with the resin. While this can be done by coating the polymer pellets with a low boiling liquid such as pentane which becomes a gas in the extruder it is preferred to blend a solid physically or chemically decomposable blowing agent with the polymers and then to feed the resulting blend into the extruder. Exemplary chemical agents include but are not limited to azobisformamide, azobisisobutyronitrile, diazoaminobenzene, 4,4' - oxybis(benzenesulphonylhydrazide), benzenesulphonylhydrazide, N,N'-dinitrosopentamethylene-tetramine, trihydrazine-symtriazine, p,p'-oxybis-(benzenesulphonylsemicarbazide)-4-nitrobenzene sulphonic acid hydrazide, beta-naphthalene sulphonic acid hydrazide, diphenyl-4,4'-di(sulphonylazide) and mixtures of materials such as sodium bicarbonate with a solid acid such as tartaric acid. The amount of foaming agent to be used in the process generally is from 0.1 to 20% by wt. of the resin being extruded with from 0.5 to 5.0% by wt. being the preferred range.

The polypropylene used in the present process is isotactic polypropylene having a melt index of below 25 g. Almost any commercial polypropylene plastic is suitable whether it be moulding, film or fibre grade. Additionally the polypropylene may be blended with up to 25% by wt. of another polymer. Suitable other polymers generally are addition polymers having melt indices of from 0.1 to 15 g. Examples of such

addition polymers are polyethylene having a density of from 0.90 t 0.96, polybutene-1, polystyrene, ethylene-vinyl acetate copolymers and polymethylmethacrylate.

The surface layer or layers are formed by the same technique but using a blend of polypropylene and a more hydrophilic or dyeable resin. The preferred more hydrophilic resins are polyacrylonitrile, polyamides, polyesters and ionomers. The preferred polyamides ae poly[ϵ-caprolactam], polyhexamethylene adipamide, polyhexamethylene sebacamide, poly[ω-aminoundecanoic acid], polyhexamethylene dodecanamide and copolymers of any of the above containing from 5 to 50% by wt. repeating units of the structure:

$$\left[\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH-(CH_2)_3-O(CH_2)_2-O-(CH_2)_3-NH \right]$$

Such polyamides, generally will be normally solid and have a molecular weight of from 10,000 to 50,000. Preferred polyesters include poly(ethyleneterephthalate) and poly(butylene-1,4-terephthalate). The preferred ionomers are copolymers containing 0.2 to 25 mole %, as based on the monomer units in the polymer of an α-β-ethylenically unsaturated carboxylic acid containing from 3 to 10 carbon atoms or styrene sulphonic acid. Examples of such monomers are acrylic acid, methacrylic acid, ethacrylic acid, itaconic acid, maleic acid, fumaric acid, monoesters of the above dicarboxylic acids such as methyl hydrogen fumarate, ethyl hydrogen fumarate and maleic anhydride, mononitriles of the above dicarboxylic acids such as β-cyano acrylic acid and monoamides of the above dicarboxylic acids such as fumaric monomethylamide. In general, it is preferred that the alcohol or amine forming the respective ester or amide, be an alkyl alcohol or amine wherein the alkyl group contains up to 10 carbon atoms. As indicated while the polymer may contain from 0.2 to 25 mole percent of the carboxylic acid monomer, the preferred range is from 1 to 10 mole percent of the carboxylic acid monomer. The remainder of the copolymer is an α-olefin containing from 2 to 4 carbon atoms. Generally the ionomer will have an inherent viscosity of at least 0.7 as determined from a 0.5% by wt. solution of the polymer in dimethylformamide at 20°C. Generally from 30 to 80% of the carboxylic acid groups are neutralized with an alkylene diamine containing 1—10 carbon atoms or metal ions. Suitable metal ions include Na^+, K^+, Li^+, Cs^+, Ag^+, Hg^+, Cu^+, Be^{+2}, Mg^{+2}, Ca^{+2}, Sr^{+2}, Ba^{+2}, Cu^{+2}, Cd^{+2}, Hg^{+2}, Sn^{+2}, Pb^{+2}, Fe^{+2}, Co^{+2}, Ni^{+2} and Zn^{+2}. Generally the blend will contain from 30 to 80% by wt. polypropylene and from 20 to 70% by wt. of the more hydrophilic resin. The more dyeable the hydrophilic resin, the less need be used.

As the resin is extruded it is taken up by a take-up means such as a first pair of nip rolls and attenuated 2 to 10 times. This attenuation serves to cause the foam bubbles forming within the die to break as the resin approaches the die resulting in a network or web of intertwined and connected fibrils. When using a polypropylene based resin the temperature within the extruder is generally maintained at from 350 to 550°F. As the polypropylene approaches the die lips it should be from 350 to 475°F. As the polypropylene leaves the die lips it is quenched as with an air quench which services to insure that the polypropylene is below 170°C or the melting point.

When using a blend of polypropylene and a polyamide resin the temperature within the extruder is generally maintained at from 350 to 475°F, as the blend approaches the die lips it should be from 475 to 550°F. On leaving the die lips the blend is quenched to below 170°C to insure that fibrils are formed.

When using a blend of polypropylene and a polyester resin the temperature within the extruder is generally maintained at from 350 to 500°F. As the blend approaches the die lips it should be from 475 to 550°F. On leaving the die lips the blend is quenched to below 170°C to insure that fibrils are formed.

When using a blend of polypropylene and an ionomer resin the temperature within the extruder is generally maintained at from 350 to 450°F. As the ionomer approaches the die lips it should be from 350 to 400°F. As the ionomer leaves the die lips it is quenched as with an air quench to below 150°C to insure that fibrils are formed. After this foam fibrillated web has been formed it is then strenched from 2 to 10 times to orient the individual fibrils which make up the web thereby strengthening the web.

In accordance with the present invention the foam fibrillated webs are adhered together by any convenient means such as the application of heat and pressure into a

non-woven fabric. If desired one or more films of thermoplastic resin having a softening point of from 80 to 170°C may be used as an adhesive. Emulsions or powders of thermoplastic resins softening from 80 to 170°C are also suitable. Resins having softening points above 170°C are not used because temperatures above 170°C cause the polypropylene resin to lose its orientation. Resins with temperatures below 80°C are not used because they can soften in use. Suitable thermoplastic resins for forming the films, powders or emulsions include but are not limited to, polyvinyl chloride either plasticized or not, polyvinylidine chloride, polystyrene and polyethylene. Unoriented polypropylene film can be used but requires close control of conditions and is not preferred for this reason. Films of resins other than polypropylene can be either oriented or not. Polyethylene resins wherein the polyethylene has a density of from 0.90 to 0.96 g/cc and a melt index of from 0.1 to 10 are preferred. Particularly satisfactory resins are polyethylene resins and ethylene-vinyl acetate copolymer resins wherein the copolymer contains from 10 to 40% by wt. vinyl acetate. Generally the die used has an opening from 5 to 50 mils in the thickness direction of the extrudate which results in the final oriented foam fibrillated webs weighing from 0.1 to 2 ounces per square yard. Generally the total weight of adhesive used should be equal to from 0.1 to 0.5 ounce per ounce per square yard of total foam fibrillated webs used in the final non-woven fabric.

The final non-woven fabric will normally contain from 3 to 20 layers. For most uses such as industrial bagging, primary carpet backing, secondary carpet backing, wallpaper, upholstery backing from 5 to 10 layers are used and the non-woven fabric product has a weight of from 2 to 10 ounces per square yard. There are a plurality of ways in which the layers of webs can be assembled. Often the way in which the webs are assembled is dependent on the use to which the non-woven product is to be put. Usually this involves 2 to 4 layers in the machine direction and 2 to 4 lapped layers at an angle thereto. However the webs can be run through a tenter frame to increase their width and impart a biaxial disposition to the direction of the individual fibrils within the web in which case all of the webs can be laid down in the machine direction and laminated.

If desired a web or bat containing fibres having a random directional disposition can be obtained by mechanically shredding the fibrillated polypropylene based resin webs followed by air laying the resulting fibres. Such a process can be carried out in a variety of specific ways. Generally the resulting bat will weight from 0.5 to 4 ounces per square yard and will be used as the inner portion of the non-woven construction with a machine direction oriented foam fibrillated web on both surfaces at least one of which is dyeable.

The preferred construction for most uses involves the use of two layers of film one on either side of two cross-lapped polypropylene foam fibrillated webs giving a total of 4 layers and one or two addtitional polypropylene foam fibrillated webs on each side simply laid down in the machine direction and one layer of dyeable foam fibrillated web. By choosing the laminating conditions (temperature and pressure) and texture of the laminating rolls or press a final non-woven fabric which is either quite porous or which is impervious to moisture can be obtained.

For most applications a single surface layer of dyeable resin blend fibrillated web is adequate. When the web is significantly lighter than usual up to 5 webs may be desired. The dyeable fibrillated webs whether used on one or both sides of the non-woven fabric should not contribute more than 25% to the weight of the final non-woven product and preferably not more than 20% by wt. Generally the dyeable fibrillated web is applied to the surface of the layers of fibrillated polypropylene webs by simply unrolling a layer thereon prior to the lamination step with no cross-lapping or other more involved procedure.

For individual laminates of from 6 inch square up to 4 ft.×8 ft. a press can be used to laminate the foam fibrillated webs together. Generally such a press is operated at from 1 to 1000 p.s.i. and preferably 10 to 500 p.s.i. and at 240 to 290°F. For long rolls of the non-woven product heated pressure rolls are used. Generally these are heated metal rolls preferably steel operated at from 2 to 50 lbs. pr linear inch pressure, from 240 to 310°F and the material being laminated is fed at a rate of from 10 to 500 feet per minute. The hand, appearance, porosity and other physical characteristics of the non-woven product can be varied considerably by varying the severity of the laminating conditions within the parameters set forth above. Further, these characteristics of the product non-woven fabric can be varied by using embossed or textured laminating rolls. If one (or if desired both) laminating rolls (or one surface of a press if such is being used) are covered with burlap or a screen of the appropriate size a non-woven fabric which looks like burlap can readily be obtained.

While the surface dyeable polypropylene based non-woven fabric of the present invention finds its principal use as a carpet backing, and particularly as a primary backing for shag carpeting; the surface dyeable non-woven fabric of the present invention has advantages in end uses such as bagging and decorative coverings.

The fibrillated webs can be prepared by mechanically working a uniaxially oriented film of the desired resin.

The invention is further illustrated by the following Examples.

EXAMPLE I

A Killian one inch extruder having a 24:1 L/D screw was equipped with an eight inch wide slip die. (Johnson Flex Lip coat hanger type) having a 20 mil thick opening. The slit was offset from the screw by 10 inches and extruded in the same direction as the flow through the extruder barrel. The extruder hopper was continuously filled with a previously blended composition which contained 100 g of polystyrene having a melt index of 5, 900 g of polypropylene having a melt index of 10 and 20 g of sodium bicarbonate. The last extruder stage and the die were maintained at 450°F. The screw was operated at 25 rpm to give a feed rate of 6 lbs per hour. Immediately adjacent the die lips was an air quench which was a pair of 0.5 inch diameter pipes one located above the die lips and the other below the die lips containing air under 80 p.s.i. pressure. Each pipe contained a row of 0.030 inch diameter holes 0.125 inch apart directed at the die lips. The extrudate was withdrawn from the die lips by a first pair of five inch diameter nip rolls eight inches in width driven at a surface speed of 10 ft./minute to form a foam fibrillated web. These rolls comprised a driven rubber covered roll and a stainless steel idler roll. The foam fibrillated web was then passed over a heated shoe eight inches wide and 36 inches long. The shoe was slightly arched in shape so as to maintain the foam fibrillated web in intimate contact with it. The shoe was maintained at 130°C. The foam fibrillated web was then passed between a second pair of nip rolls identical to the first pair of nip rolls and was then taken up by a take-up reel. The second pair of nip rolls were operated at 60 ft./minute. The resulting strong fibrous web was used as the sample base in the following examples.

EXAMPLE II

Example I was repeated except the feed to the extruder was a blend of 500 g of polypropylene having a melt index of 10, 500 g of polycaprolactam having a flow number of 10, and 20 g of sodium bicarbonate. The last extruder stage and die temperatures were maintained at 232°C and 265°C respectively. The initial draw was 14 feet per minute, the secondary draw was 39 feet per minute and the shoe temperature 110°C. The resulting fibrous web was used as the dyeable surface of a fabric.

EXAMPLE III

Three layers of the fibrous webs from Example I were laid up to form a laminate with the first layer having the fibres aligned in what would be the machine direction in a continuous line. The second and third layers were in a parallel plane to the first layer but with the fibres aligned at 90° to the fibres of the first layer to form a cross layer. Next, a 2 mil thick polyethylene film was placed on the sample again in a parallel plane. Finally a layer of the fibrous web of Example II was laid in a parallel plane with the fibres aligned in a direction parallel to those in the first layer. The thus laid up sample was placed between polished sheets and placed in a press which was operated at 20,000 lbs. pressure (9″×12″ platens) and 138°C for 3 minutes. After cooling the resulting white fabric was removed from the polished sheets, placed between 10 mesh stainless steel screens and pressed at 10,000 lbs. pressure at 138°C for 30 seconds. The resulting non-woven fabric had the appearance of a woven fabric. The fabric was then immersed in a 500 ml dye bath initially containing 2 g/l Xylene Milling Blue (Colour Index No. Acid Blue 102) and 8 g/l ammonium acetate for 15 minutes at 100°C. The resulting blue fabric was rinsed thoroughly in cold water, then washed in a 90°C detergent solution, and rinsed in 70°C water. It retained a deep blue colour on the side formed from the fibrous web of Example II with little permanent coloration of the remainder of the sample. The sample had a Grab Tensile of 60 lbs in the machine direction and 75 lbs in the cross direction.

Another sample of the same undyed non-woven fabric was immersed in a 500 ml dye bath initially containing 2 g/l Latyl Cerise N (Colour Index No. Disperse Red 60 Ref 5197) for 30 minutes at 100°C. The resulting pink fabric was washed thoroughly in cold water, then washed in a 90°C detergent solution and then rinsed in 70°C water. The sample retained a deep pink coloration on the side formed of the fibrous web of Example II and a less intense pink on the rest of the sample.

WHAT WE CLAIM IS:—

1. An oriented foam fibrillated web formed of a blend of from 30 t 80 percent by weight of polypropylene and from 20 to 70 percent by weight of a more hydrophilic dyeable resin which web weighs from 0.1 to 2 ounces per square yard.

2. A foam fibrillated web as claimed in Claim 1 wherein the dyeable more hydrophilic resin is a polyamide.

3. A foam fibrillated web as claimed in Claim 2 wherein the polyamide is polyhexamethylene adipamide.

4. A foam fibrillated web as claimed in Claim 2 wherein the polyamide is poly-ϵ-caprolactam.

5. A foam fibrillated web as claimed in Claim 1 wherein the more hydrophilic dyeable resin is a ionomer resin.

6. A foam fibrillated web as claimed in Claim 1 wherein the more hydrophilic dyeable resin is a polyester.

7. A foam fibrillated web as claimed in Claim 6 wherein the polyester is poly-(ethylene terephthalate).

8. A foam fibrillated web as claimed in Claim 1 substantially as described with reference to Examples 2 or 3.

9. A non-woven fabric weighing from 2 to 20 ounces per square yard prepared from fibrillated polypropylene or blends thereof with up to 25 percent by weight of polyethylene or polystyrene which non-woven fabric has bonded to at least one surface thereof a foam fibrillated web as claimed in any of the preceding claims which web constitutes up to 25 percent by weight of the non-woven fabric.

10. A non-woven fabric as claimed in claim 9 substantially as described with reference to Example 3.

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1976.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1 454 218 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

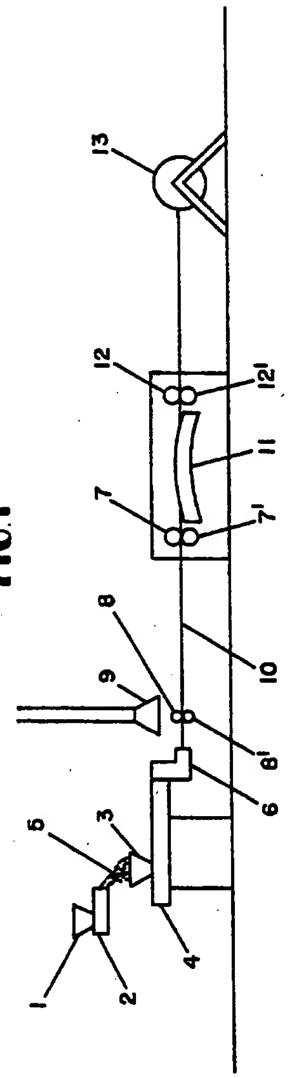

FIG.1

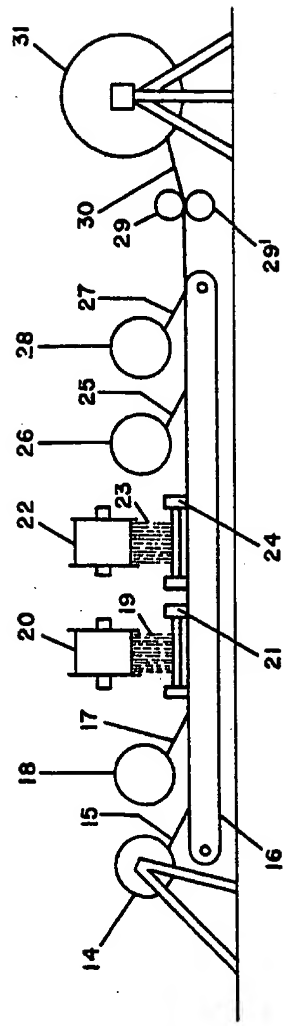

FIG.2